

Influence of muscle strength in the volume and intensity of daily physical activity in elderly

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Abstract

Reduction in the volume daily physical activity (VAF – number of steps) and in the intensity of daily physical activity (IAF– average walk velocity) are related with higher incidence of falls and increase of incidence of chronic diseases in elderly. However, the identification of factors which may increase the VAF and the IAF became essential, especially in this population. Therefore, the aim of the present study was to investigate the influence of muscle strength in VAF and the IAF of older healthy elderly. It were recruited 18 participants, ten men and eight women, aged above 60 years old. The participants performed the one repetition maximal test (1-RM) and afterwards they used the triaxial accelerometer, during seven consecutive days, to measure the VAF and the IAF. To analyze the influence of muscle strength in the VAF and IAF a simple linear regression analysis was performed. It was not observed significant correlations between the muscle strength and the VAF ($p = 0.93$; $r^2 = -0.06$), or between muscle strength and the IAF ($p = 0.08$; $r^2 = 0.17$). In conclusion the muscle strength does not influence the VAF and IAF of healthy older adults.

KEY WORDS: Aging; Triaxial accelerometer; Number of steps; Walking speed.

Introduction

Aging is accompanied by decrease in daily physical activities level. This reduction can be measured through a decrease in the number of steps (volume of physical activity [VPA]) and/or a decrease in average walk velocity (intensity of physical activity [IPA])¹⁻³. The decreased level of daily physical activity, expressed by reductions in VAF and IAF, has an important impact on the health of older individuals as it is related with an increased risk of falls⁴ and development of chronic degenerative diseases (e.g., type II diabetes)⁵⁻⁷. Thus, it becomes important to identify the factors that can influence the VPA and IPA, as preventive strategies can be developed to maintain and/or increase both VPA and IPA in elderly.

Among the factors that can influence the VPA and IPA in the elderly, one is muscle strength. In fact, it has been reported a positive correlation between muscle strength and VPA, as well as a positive correlation between muscle strength and IPA^{3, 8-10}. However, the methods used by these studies^{3, 8-10} prevents a more assertive conclusion about the influence of muscular strength in VPA and IPA. For example, the use of questionnaires, though validated, do not allow precise quantification of the VPA and the IPA. On the other hand, with the aim of minimize the possible disadvantages of questionnaires, and ensure greater accuracy in measuring the VPA and the IPA, the studies has

been used triaxial accelerometer^{3, 10}. The triaxial accelerometer is a sensitive device to measure acceleration in each of the three body's axes (i.e., vertical, medial-lateral and anterior-posterior)¹¹. Thereby, the triaxial accelerometer is able to measure and store large amount of physical activities' data daily (i.e., VPA and IPA). Additionally, the triaxial accelerometer is a small, full fit and portable device, thus, does not interfere with the any subjects' life activities¹². Although these advantages, the studies that used triaxial accelerometer to quantify the VPA and the IPA also showed some limitations (i.e. the short time of acquisition [only 24 h])^{3, 10}. A limited time record of VPA and IPA may compromise the results, since 24 hours may not reflect the real daily life of the elderly³. Furthermore, another limitation is the use of triaxial accelerometer with the total acquisition time of VPA and IPA unstandardized¹⁰.

This lack of standardization may mainly influence the VPA, as the elderly with longer use of triaxial accelerometer may present a greater VPA compared with those who used the triaxial accelerometer for a short time. Thus, with the experiments conducted until the present moment, it is not possible to draw definitive conclusions regarding the influence of muscle strength in the VPA and the IPA in elderly.

Therefore, the aim of this study was to investigate on the influence of muscle strength in the VAF and the IAF in healthy elderly subjects using a triaxial accelerometer for seven consecutive days. We hypothesized that the levels of muscle strength is not associated with daily VPA and IPA of health elderly. Understanding the influence of the muscle strength in the VPA and IPA can contribute to the development of intervention strategies to increase the level of daily physical activity in elderly.

Method

Participants

The sample included 18 volunteers, 10 men and eight women. Participants should be over 60 years old and could not have performed aerobic and/or strength training six months before the study to be included in the present study. Exclusionary criteria were: presence of myocardial disease, diabetes, arrhythmias, hypertension, musculoskeletal injury and not have been approved in a clinical evaluation consisted of an effort electrocardiogram. All participants signed an informed consent including the benefits and risks of the study, which were also previously orally explained. The study was approved by the Ethics Committee at the local University (1303/2011).

Study design

Initially, the participants performed anthropometric assessments and two familiarization sessions for leg-press exercise with a 48 hours interval in between. Three days after the last familiarization session, the participants performed two session of one repetition maximum tests (1-RM) (with 72 hours of interval) to determine the muscle strength. A week after the 1-RM test, the participants used the triaxial accelerometer for seven consecutive days to measure the VPA and the IPA.

Anthropometric assessment

Body mass was measured by a mechanical balance with accuracy of 0.1 kg (Filizola, São Paulo, Brazil). Height was measured by a wooden stadiometer with accuracy of 0.1 cm. Body mass index (BMI) was obtained by the equation: body mass/height².

Maximum dynamic strength test (1-RM)

Muscle strength was assessed by the 1-RM test, following descriptions of BROWN and WEIR¹³ in the leg-press exercise. Before the test, the participants performed a general warm-up on a cycle ergometer at 60 rpm and 25 watts for five minutes, followed by specific warm-up. In the first set, participants performed eight repetitions with load corresponded to 50% of their estimated 1-RM obtained during the familiarization sessions. One minute after (second set), the participants performed three repetitions, with load corresponded to 70% of their estimated 1-RM. After a three minutes interval, the test was performed with the aim of obtain the maximum amount of weight (kg) in a complete cycle (flexion-extension of the knee joint with total range of motion of 90°). The total number of attempts to determine the value of 1-RM in each test was not greater than five. The interval between attempts was set at three

minutes. The 1-RM tests were performed in the morning (between 7 and 11 am). Volunteers were allowed to drink water at ad libitum during the tests. The typical error and the coefficient of variation were 23.05 kg and 9.12% respectively.

Assessment of the daily physical activity level

The total numbers of steps performed during the seven days (Volume of daily physical activity [VPA]) and average walk velocity (average of seven days) (Intensity of daily physical activity [IPA]) were used to achieve the daily physical activity level, using a triaxial accelerometer (PAMSys; Biosensics, Cambridge, MA), size 5.1 cm x 3 cm x 1.6 cm, weight 24 g and frequency of 40 Hz. The triaxial accelerometer was used for seven consecutive days and was only removed in the shower. The triaxial accelerometer was positioned at the abdominal region, specifically in the umbilical line using an elastic belt.

Statistical analysis

Data from the anthropometric characteristics, muscle strength, VAF, IAF and the accelerometer usage time are described as means \pm standard deviations. Data normality was assessed through the Shapiro-Wilk test. Subsequently, the simple linear regression analysis were performed between muscle strength and number of steps and between muscle strength and average walk velocity. Firstly, the simple linear regression was performed for each sex separately (men, $n = 10$; women, $n = 8$), and afterwards for the total sample ($n = 18$). The significance level was set at $p < 0.05$. Statistical analyses were performed using Statistica version 6.1 software (StatSoft Inc, Tulsa, OK, USA). The 1-RM test-retest reliability¹⁴ (coefficient of variation, CV) was determined using two tests separate by three days.

Results

Participants' characteristics are described in TABLE 1.

The result of the linear regression between muscle strength and the VPA using the total sample (men and women) is shown in FIGURE 1. There was no significant correlation between muscle strength and the VPA ($p = 0.93$; $r^2 = -0.06$). FIGURE 2 shows the result of the linear regression between muscle strength and the IPA using the total sample (men and women). There was no significant correlation

between muscle strength and IPA ($p = 0.08$, $r^2 = 0.17$).

The simple linear regressions between muscle strength and VPA separated by sex showed no significant correlations for both men ($p = 0.32$, $r^2 = 0.12$) and women ($p = 0.40$; $r^2 = 0.11$). Similarly, the simple linear regressions between muscle strength and IPA separated by sex showed no significant correlations for both men ($p = 0.77$, $r^2 = 0.01$) and women ($p = 0.63$; $r^2 = 0.04$).

TABLE 1 - Characteristics of participants.

Variables	participants (n = 18)
Age (years)	64.7 \pm 4.4
Body mass (kg)	74.3 \pm 12.6
Height (cm)	164 \pm 1.0
BMI (kg.m ⁻²)	27.2 \pm 2.6
Muscle strength (kg)	241.9 \pm 114.7
VPA (number of steps)	69344.0 \pm 42544.0
IPA (km/h)	2.1 \pm 0.1
Time of use of the accelerometer (hours)	164.2 \pm 14.7

BMI = body mass index;
VPA = volume of daily physical activity;
IPA = intensity of daily physical activity.
Data are shown as the mean \pm SD.

($p = 0.93$; $r^2 = -0.06$).

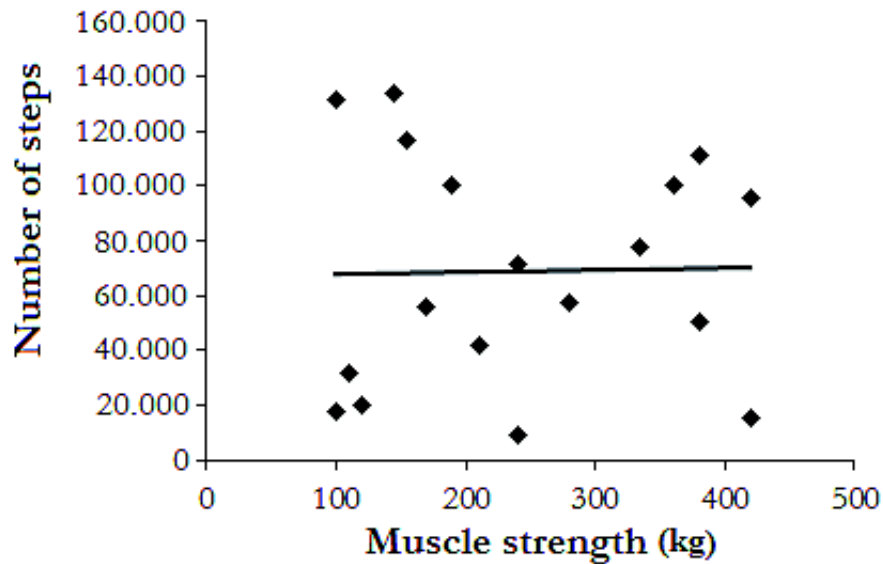


FIGURE 1 - Simple linear regression between muscle strength and the number of steps (volume of daily physical activity [VPA]).

($p = 0.08$; $r^2 = 0.17$).

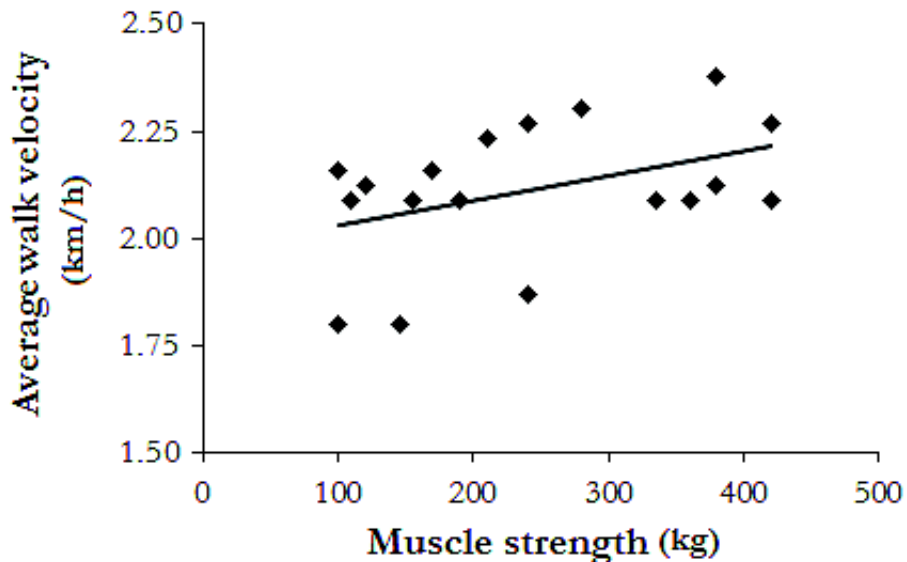


FIGURE 2 - Simple linear regression between muscle strength and the average walk velocity (intensity of daily physical activity [IPA]).

Discussion

The aim of the present study was to investigate on the influence of muscle strength in the VPA and the IPA of healthy elderly during seven days consecutives using a triaxial accelerometer. Corroborating our initial hypothesis, the results not showed significant correlations between muscle strength and VPA, as well as between muscle strength and IPA.

In this sense, our results are not confirming others that have shown that muscle strength may

influence the VPA⁸⁻⁹. For instance, SCOTT et al.⁹, found significant correlation, although low ($r^2 = 0.01$) between muscle strength and VPA. Similarly, GARCIA et al.⁸ also showed significant correlation ($r = 0.51$) between the level of physical activity and the knee extension torque of old adults. However, the study by GARCIA et al.⁸ measured level of physical activity using questionnaire. The questionnaires are overwhelmingly validated and are easy to apply,

thus are a great strategy for epidemiological studies. Nevertheless, questionnaires do not allow an effective distinguish between VPA and IPA. Additionally, questionnaires are subjective methods, therefore in can lead to inaccurate responses¹⁵. In fact, the main factor that may contribute to the increase in the VPA is still uncertain. We suggest that the magnitude of muscle strength (i.e. maximum strength) does not affect the VPA, at least in healthy older adults, as the activities in their daily lives are mainly of low intensity. Thus, it is possible that the ability of the elderly to carry out a submaximal force (e.g., local muscular endurance, maximal number of repetitions) over a longer period may affect the VPA in this population.

Similar results were observed in this study for the IPA. No significant correlations were observed between muscle strength and the IPA, both considering the total sample, as when separated by gender. On the other hand, several studies have shown that muscle strength is associated with walking velocity¹⁶⁻¹⁸. However, these studies refers only to the maximum velocity in short and predetermined routes (e.g. 15 m), which is quite different from the average speed in daily activities¹⁶⁻¹⁸. LAUDANI et al.³ investigated the association of strength with the IPA measured by accelerometer used only for one day. The researchers found that peak torque of the knee extensors has significant, but low ($r = 0.26$), correlation with the IPA. PUTHOFF et al.¹⁰, also showed a moderate correlation between muscle strength and the IPA ($r^2 = 0.39$). One possible explanation for these studies present divergent results from the presented herein may be linked to the time of accelerometer usage. The study of LAUDANI et al.³ used accelerometer for only 24 hours, while in the present study it were used for seven consecutive days. Assessing only 24

hours may increase the possibility of measuring an exceptional atypical day, underestimating or overestimating the actual daily life activities level of the older participants. On the other hand, the study of PUTHOFF et al.¹⁰ assessed the VPA and IPA during six consecutive days. Even determining a minimum time of accelerometer usage of eight hours, the authors did not report the total time of measurement. It is of great importance that the total time of accelerometer usage is similar among participants as it is possible to speculate that different values, the VPA and IPA, could be observed with different sampling times (e.g. 8 and 16 hours). In order to avoid this type of bias in this study, our participants used the accelerometer for 24 hours a day, except shower period (~162 hours). Thus, it is reasonable to suggest that muscular strength does not influence the IPA in healthy older adults.

Although of the hard designing and methodological approach to the problem, some limitations of the study should be understood. First, this study is an observational study, which do not allow drawing any causal relationship between variables; secondly, our findings should be extrapolated that only healthy elderly; and finally, a low power of the study was found ($1-\beta$) for both correlations (muscle strength and VPA = 0.17, and muscle strength and IPA = 0.43).

In summary, we conclude that muscle strength seems not to influence VAF and IAF of healthy older adults. Considering that the maintenance and/or increasing the VPA and IPA are important to the elderly population health, it is suggested that further studies should investigate whether other manifestations of muscle strength, such as local muscular endurance (number of repetitions) or even muscle power can influence the VPA and/or IPA.

Resumo

Influência da força muscular no volume e na intensidade da atividade física diária de idosos

Diminuições no volume da atividade física diária (VAF – número de passos) e na intensidade da atividade física diária (IAF – velocidade média de caminhada) estão relacionadas com a maior incidência de quedas e aumento da incidência de doenças crônico-degenerativas em idosos. Portanto, identificar fatores que possam aumentar o VAF e a IAF torna-se essencial, principalmente para essa população. Desta forma, o objetivo do presente estudo foi investigar a influência da força muscular no VAF e na IAF de idosos saudáveis. Foram recrutados 18 participantes (10 homens e oito mulheres), com idade acima de 60 anos. Os participantes realizaram o teste de uma repetição máxima (1-RM) e utilizaram acelerômetro triaxial durante sete dias consecutivos, para mensurar o VAF e a IAF. Para analisar a influência da força no VAF e

IAF realizou-se uma análise de regressão linear simples. Não foram observadas correlações significantes entre a força muscular e o VAF ($p = 0,93$; $r^2 = -0,06$), assim como, entre a força muscular e a IAF ($p = 0,08$; $r^2 = 0,17$). Conclui-se que a força muscular não influencia o VAF e a IAF de idosos saudáveis.

PALAVRAS-CHAVE: Envelhecimento; Acelerômetro triaxial; Número de passos; Velocidade de caminhada.

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